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# ***Strategic Data Farming***

Deborah Duong



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## *Human Judgment in Analysis*

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- How can we take advantage of human judgment in a way that is good for analysis?
  - Human beings have such better understanding of human contexts than computers do
  - In analysis like irregular warfare that involves the human terrain, this is more important
- The DoD does not trust computer simulation in this domain, and employs wargaming
  - But it is difficult to get enough repetitions for statistical significance of human judgments
  - They have compromised by using computer wargame adjudicators of social phenomena.
    - PSOM, SEAS, COMPOEX, etc.



## ***Computer Adjudicators for Wargames***

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- Is it a good idea to use a computer adjudicator for a wargame for analysis?
  - You could get this worst of both worlds...
    - We are spending lots of money on the games and the software but,
    - You won't have enough repetitions to get statistically significant results anyway
    - The computer are usually better at playing a game, on its own terms, than humans are!
      - The world champion at chess is a computer program
- Model-Game-Model Technique
  - Uses iteration between human and computer to gain the best of both worlds
  - Humans are used to improve the model, not replace it





## ***Model-Game-Model Technique***

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- Model Phase
  - Explore how the environment in the game may be manipulated so that an agent (human or ABS) may achieve its goal
  - Bring ways to “game the game” are to the surface
  - Modelers and Subject Matter Experts (SMEs) may change the game so that players win in more realistic ways
- Game Phase
  - Players play the improved game
  - Players suggest outcomes that are more realistic
  - Modelers may change the game so that players win in more realistic ways
- Model Phase
  - After several iterations, realism increases to the point that human beings are not needed to win in a realistic fashion, at which point automation (and statistical significance) is possible



## ***Strategic Data Farming***

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- Strategic Data Farming may be employed in the first phase of the iterative model-game-model process
  - Strategic Data Farming is a way to explore how a player or an agent may succeed in a wargame or an agent based simulation (ABS)
    - Ways to game the game are exposed
- Strategic Data Farming makes use of Game tree technology from Artificial Intelligence
- Strategic Data Farming looks at worse-case-scenarios first
  - Desirable for analysis
  - Game trees win by the exploration of the worse case



## ***Why do ABS and Wargames need Strategic Data Farming?***

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- ABS and wargames are typically nonlinear
  - New combinations of parameters contain surprises
  - Traditional parameter sensitivity testing for VV&A is inadequate
- Traditional Data Farming does a thorough exploration of the state space
  - Seeks to explore every combination of parameters
  - Takes supercomputers and vast computational resources
- In Strategic Data Farming, the emphasis is on the game theory of moves rather than parameters
  - There are usually fewer parameters in strategic games
    - What makes a game unique is strategy
  - Assumption of goals narrows down what exploration





## Questions Answered

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- Traditional Data Farming answers the basic questions of Agent-Based VV&A
  - Is every model outcome possible in the real world?
  - Is every possible real world outcome realizable in the model?
- Strategic Data Farming answers the basic questions of strategic games
  - Do strategies that win in the simulation win in the real world?
  - Do strategies that win in the real world win in the simulation?
- For Strategic Data Farming, once the model is refined so that the answer is yes, the game may be automated



## ***How Strategic Data Farming Works***

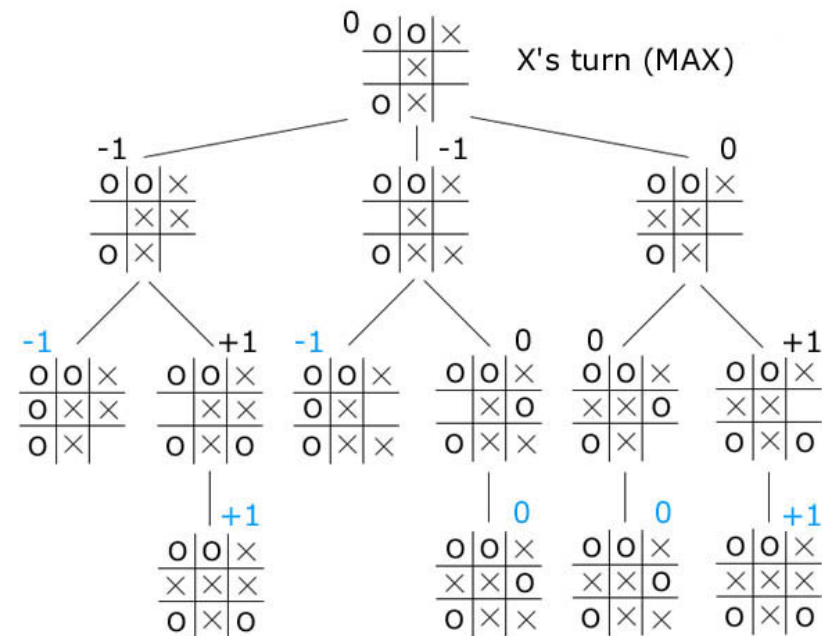
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- Replace a player or an agent of a wargame adjudicator or agent based simulation with an game tree agent
- The game tree agent needs 3 things
  - A board evaluation function: a way to tell how far the agent is from its goal for a particular state of the board
  - A list of all the legal moves that the player can make
    - If there are too many, they should be ranked according to their usefulness for a strategy
  - A list of all the changes that can be made in the agents environment
    - May include other moves of the players
    - If there are too many, they should be ranked according to how harmful they are to the agent's strategy
- Invert the game



# How Game Inversion Works

- Play the game as though there are only 2 strategists
  - The replaced agent
  - The rest of the simulation
- A game tree is created in which the rest of the simulation is pitted against the agent's goals
  - The simulation itself is used to advance to the next move
  - The game is “branched”: For every move made, the top N moves of the opponents are tried
  - Alpha beta minimax quickens the search
  - A move is chosen when goal is reached or computational limits are reached
- Replace every agent in the simulation, or player in the game, in the same fashion





## ***What Strategic Data Farming Makes Possible***

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- Increased fidelity of wargames and agent based simulations
- Replacing the players for full automation
  - Once it is impossible to “game the game” the computer can usually play the game better than a human can
  - Human creativity doesn’t matter to who wins game
    - Imagining meanings for chess moves never won the game
    - The player can not increase the ways to win the game, he can only eliminate consideration of non-human ways to win
  - If the problem is analysis, this will save human resources and make runs statistically significant
  - Only applicable to closed games (That only machines adjudicate)



## ***Myths of Game Theory Techniques***

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- A game tree agent makes players act rationally while people are irrational in the real world
  - Game tree agents evaluate their environment according to their goals. These may be religious, or private
- Sometimes people just miss things or behave stupidly, but we are not exploring those instances
  - Game tree agents do not need to take poor moves into account in order to calculate how to win the game
- Game trees can not handle real world moves
  - Modern game tree technology can
    - Use heuristics to rank moves
    - Take into account simultaneous moves
    - Take perception into account
      - As in poker
    - Take probability into account



## Summary

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- Strategic Data Farming can perform validation and enable automation in agent based simulations and in wargame adjudicators
- Strategic Data Farming narrows the space of possibilities that need exploration in strategic games
- Strategic Data Farming does not limit human creativity in analysis anymore than the simulator itself does